

TIE TO ECONOMICS CONSEQUENCE
Agricultural

DRAFT
PROPOSAL

ON

ENVIRONMENTAL IMPACT OF ILLICIT MARIJUANA
CULTIVATION IN SELECTED REGIONS OF JAMAICA

SEPTEMBER 17, 1987

from

BATTELLE

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INTRODUCTION

Considerable attention and effort has been devoted to influencing the control of illicit drug production outside the United States. One strategy is to illustrate to foreign leaders the environmental and associated socioeconomic consequences of continued production of the illicit crops. The U.S. desires to continue and enlarge on this strategy.

In particular, many of the growing regions for these crops are located in fragile ecosystems. The growing regions to be included in this program often are located in tropical or subtropical climates on steeply sloped, highly erosive, thin, and leached soils with virgin woody species cover. Deforestation and certain other agricultural practices in these environments are known to have devastating short- and long-term effects on the environment, and on related socioeconomic factors (Figure 1). Among other negative consequences, deforestation interrupts for extended periods the intricate and balanced, primary and secondary, productivity of tropical soils, flora, and fauna. Destruction of genetic resources (germplasm) also is an important consequence of tropical deforestation.

Battelle has been asked to prepare this proposal with a view toward providing technical and socioeconomic information which can be used to support the strategy.

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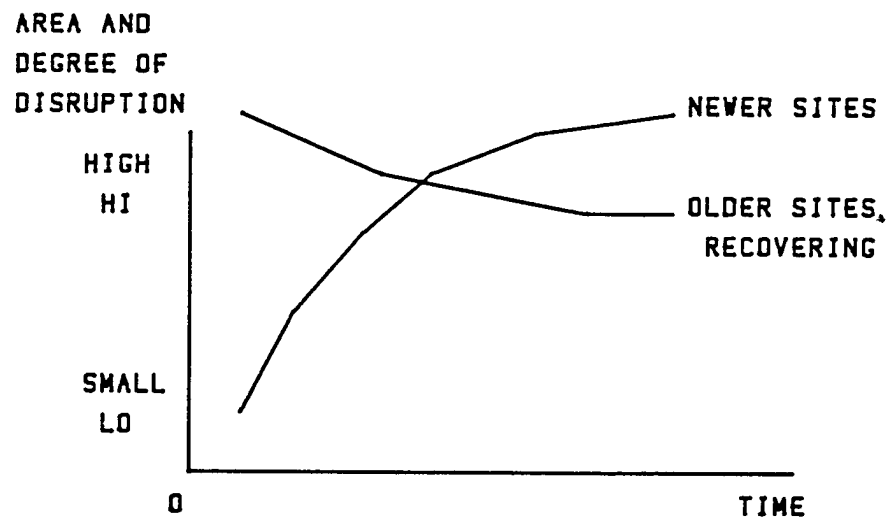


FIGURE 1. THE DEVASTATING ENVIRONMENTAL AND SOCIOECONOMIC CONSEQUENCES OF DEFORESTING AGRICULTURAL PRACTICES ARE RAPID, AND RECOVER SLOWLY

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The focus of this program is on identifying and assessing the natural and socioeconomic resource effects which result from growing marijuana in Jamaica. The output should support U.S. policy development, be country-specific, and have a material bearing on leaders' decision-making with respect to active inhibition of the illicit crop production. The major emphasis of this program is on direct environmental and socioeconomic effects. Lesser emphasis would be placed on effects of a micro-scale (i.e., on the grower) or on macro-scale issues (i.e., global climate). The results of this program, if positive, should provide a framework for conducting similar work in additional countries and with additional crops.

This document describes our understanding of the program's objectives and scope, our suggested approach for meeting the objectives, the anticipated program output, a preliminary schedule of activities, and a description of the core program team members and their experiences.

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OBJECTIVE AND SCOPE

The primary objective of this program is to:

- Identify, describe, and document for the region of interest the major environmental consequences, and the related socioeconomic implications, of the production of the illicit marijuana crop. This information will be used to encourage leaders to actively inhibit the illicit crop production.

Our goal is to create and conduct a tightly focused program yielding highly usable results. The results also can establish a framework for future programs that can focus on other aspects of the problem. To that end, several elements delineate the scope of the program.

- Geographic Region. The spatial focus of the program includes certain areas of west-central Jamaica that currently or potentially are impacted by illicit marijuana growing. The areas included in this geographical focus collectively can be termed 'affected regions'. More detailed geographic descriptions of the focus regions need to be developed through discussion with our client. There will be a need for analysis on an 'affected region' basis, as environments and likely effects differ across areas.
- Crop. Marijuana is the crop of interest in this region.
- Environmental Implications. We will be focusing on examining direct effects (changes of vertical and horizontal aspects of vegetative cover, soil fertility, local erosion, flooding, in-stream sedimentation, loss of nutrients from burned vegetation, recovery rates on growing areas, etc.) of both short- and mid-term nature. Indirect and long-term effects, such as possible changes in fauna, climate, atmospheric conditions, etc. would receive less attention in this program (Figure 2).

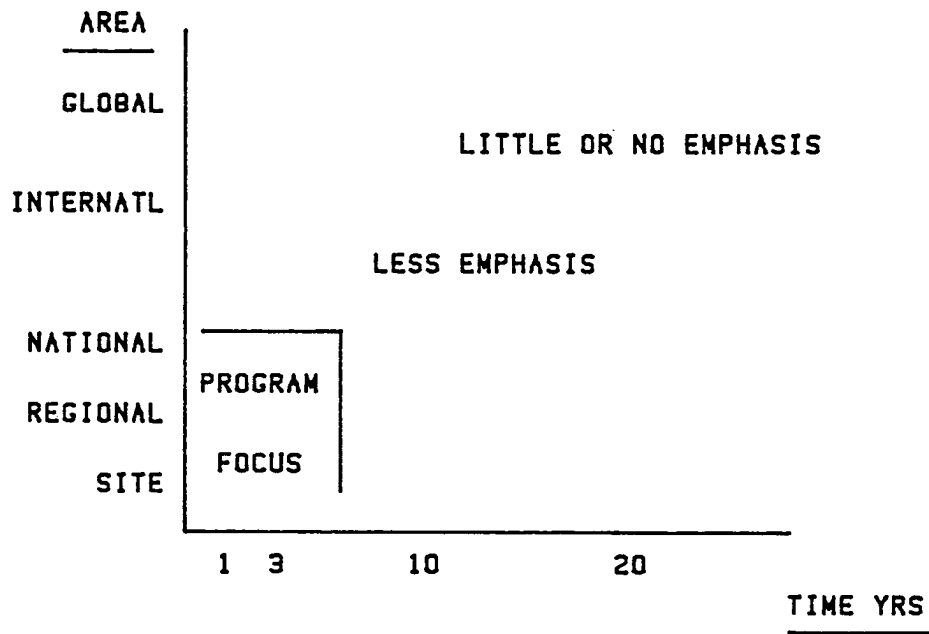


FIGURE 2. THE FOCUS OF THE PROGRAM IS ON NATIONAL "AFFECTED REGION" BASES, AND ON NEAR- TO MID-TERM AFFECTS

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- Socioeconomic Implications. This element is designed to allow us to integrate and convert the findings from the environmental analyses to socioeconomic variables and descriptions.

As with environmental effect descriptions, we will be examining direct as opposed to indirect or distant effects. In this program, we will concentrate first on the implications to the drug-growing region of the producing country, giving lesser attention to its growers, alternative employment, and alternative crops. Downstream costs in the countries of consumption are outside the scope of this program.

Socioeconomic implications of illicit crops cultivation may far outweigh the direct socioeconomic implications. The development of underground economies alienates participants from the law-abiding citizenry of the country. Illicit crop cultivation also leads entire regions of the country to fall under the control of "protecting" guerilla and organized crime groups. Intra-country aid programs also can be affected.

Costs will be monetarily quantified within the context of supporting policy, and when sufficient supporting documentation is available. Otherwise, costs will be stated in environmental and socioeconomic terms on a per unit basis for 'affected regions' (e.g., loss of soil or nutrients per hectare; hectare-years of habitat destruction). We will express the observed and measured costs of illicit crop growing on a regional basis since each cropping site affects areas beyond the actual site borders through in-stream sedimentation and other processes. We believe that focusing on the overall costs to the regions that support illicit crop growing, rather than on the costs to individual illicit crop plots will provide results more central to the needs in this program.

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ANTICIPATED RESULTS

We anticipate being able to accomplish the following in this program:

- Develop descriptions for the 'affected regions' of the direct near- and mid-term environmental effects to soils, vegetation, and waterways, and the associated socioeconomic implications of growing the illicit drug crop. The major emphasis will be on the environmental impacts of the illicit agricultural systems, placed in an socioeconomic context.
- Develop documentation supporting the effects and implications through review of the scientific literature, photographs, on-site sampling and analyses, and interviews with local and international experts in the field. Where possible, 'before and after' analyses will be depicted.
- Provide a concise report of our key findings designed to meet the needs of our client and to be credible to the political leaders (parish, national) in the country. The scientific and technical support to our conclusions and implications will be provided in appendices.
- Develop and utilize Geographic Information System (GIS) database of imagery and collateral data assembled for the 'affected regions'.
- Provide a briefing package consisting of report supplements in the form of high quality imagery of altered sites, captioned 35 mm slides, and a narrated videotape presentation usable for audiences with the foreign leaders and in other contexts.

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APPROACH

Battelle proposes a four-task approach to this program. The four tasks are:

- Task A. Detailed Planning and Resource Acquisition
- Task B. Resource Loss Analysis
- Task C. Implications Analysis
- Task D. Reporting.

This approach will facilitate an orderly development of information to reach our anticipated results. Each of the four tasks and their interrelationships are described below.

Task A. Detailed Planning and Resource Acquisition

Objectives

Task A is the major planning activity of the program. During this task, the Program Management and Core Team will convert the approach outlined in this proposal into specific assignments and responsibilities for Battelle team members. In addition, all literature, imagery and other information needs will be identified and acquired.

Our client liaison should participate in this task not only as an informational resource, but also to assure that the final plans remain directed to our client's specific needs. This program (its objectives, time, budget, etc.) is not amenable to major changes in direction, repeat of tasks, or multiple field visits to the same sites.

Strategy

Task A will be consist of four steps, each needing to be accomplished concurrently during the first two weeks of the program.

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Step A-1. Produce Work Plan and Methodology. The work plan outlined in this proposal will be expanded to specific assignments and responsibilities for program team members. Any modifications to the approach will be made at this time.

Step A-2. Access Literature. The current literature will be consulted and utilized with the technical and experimental approaches proposed for this study. Literature searches will be run concurrently by Battelle's Columbus (BCD) and Northwest (BNW) Divisions. BCD will identify and acquire literature relevant to environmental damage caused by licit and illicit slash and burn agriculture. BNW will identify and acquire relevant remote sensing and spectral radiometry literature. In addition to information already housed within Battelle's files, literature searches will be conducted on computerized international literature databases through the DIALOG database service. Battelle has on-line access to DIALOG and has established methods for rapid retrieval of potentially interesting references.

One of the goals of the literature search will be to characterize the life cycles of altered sites, and the human parameters affecting these sites. Life cycle information includes planting and harvesting cycles, frequency of site reuse, and other information. Human parameters include relative preferences for southern exposures, degree of slope, biomass density of candidate illicit crop plots, planting practices, and abandonment of sites.

Concurrent with conducting the literature searches, the program team will identify appropriate individuals in tropical agriculture, forestry, ecology, remote sensing, and narcotics cultivation to be interviewed as needed during the course of this program. Interview appointments will be set up with appropriate experts. We anticipate that interviews will be conducted within both the U.S. and in Jamaica.

An attempt will be made specifically to access information available at the University of Mississippi's marijuana research facility. A first-cut list of candidate in-country (faculty) interviewees will be developed between Battelle and Dr. Fredrich early in the program and expanded throughout the first month of the program.

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Step A-3. Acquire Imagery Resources. During this step, all appropriate imagery-related data (to be provided by the client) will be acquired by BNW. Both image and collateral data will be acquired and digitized to initialize the Geographic Information System. At this time, the available imagery-related data will be compared with the needs of the program; any potential problems will be identified and resolved. The imagery needs of the program will be finalized through discussions between the client and Battelle.

Three phases of activity involving imagery are presumed in the tables:

- orientation, and overview for site selection
- analysis of and extrapolation from site visits
- final reporting.

Step A-4. Pre-Field Visit Meeting. Once all major program resources have been acquired, members of the program team will meet to finalize plans for the Resource Loss Analysis task. This meeting will take place at BNW where imagery and collateral data will be available for review. The client will participate in at least part of the workshop to provide guidance in selecting study sites and to comment on proposed strategies.

More specifically, the objectives of the meeting are to:

- review initial work plan and refine as needed
- delineate specific field study sites/areas
- discuss field methods
- plan field protocol for resource losses via video and still photography
- review acquired image and collateral data
- provide maps, imagery, photographs, and other materials needed by the field team for the field visit.

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Delineation of the study sites (the second meeting objective) merits further elaboration. Because all altered sites cannot be observed by the program team, a sample of these sites will be selected for use in making field measurements. The sample size necessarily will be small. Therefore, it is important that the sample be representative. Also, it is important that the sampled sites be located in representative watersheds. Guidance will be sought from the literature and from the client liaison in selecting representative altered sites.

Schedule

This task should be initiated immediately upon initiation of the program, and acquisition of all literature and image-related data should be completed no later than the fourth week of the program.

Task B. Resource Loss Analysis

Objectives

The overall objective of this task is to estimate the environmental damage caused by illicit cultivation of marijuana in Jamaica. Environmental damage will be measured in terms of five types of resource loss:

- soil
- habitat
- water
- biomass
- genetic.

Losses of these resources will be estimated for the entire 'affected regions'. These estimates of environmental damage will serve as the primary input for evaluating the total environmental, and socioeconomic implications of illicit crop cultivation.

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Strategy

Our strategy for estimating losses by type includes using published and verified procedures where they exist, utilizing digital analysis for quantitative measures across 'affected regions' and across the country where we can reliably, and carrying out credible, creative manual calculations and descriptions of loss when more automated procedures will not work. Task B is divided into four steps.

Step B-1. Define Resource Loss Estimation Procedures. A separate estimation procedure will be devised for each of the five types of resource loss. Some of the estimation procedures will be derived from information available in the literature which has been validated and appended through field observations. The loss estimation procedures will require from imagery estimates of the numbers and sizes of altered sites in the 'affected regions'. However, most of the actual resource loss calculations may need to be done manually (rather than through digital analysis) because we do not anticipate that the particular resources could be measured in the field and then correlated with imagery data with confidence. This is especially true for the genetic resources loss category.

Other resource loss estimation procedures may be able to be automated to a greater extent, e.g., soil loss -- presuming that degree of slope, percent vegetation cover, and rainfall data are available in the GIS image and collateral data, we may be able to estimate loss largely via digital analysis.

Step B-2. Define Affected Regions Spatially, Physically, and Temporally. The spatial focus of this program includes the mountainous areas of western Jamaica which currently or potentially are impacted by illicit marijuana growing. The areas included in this geographical focus collectively are termed 'affected regions'. More detailed geographic descriptions of the focus regions need to be developed. As an example of a narrowing of geographic descriptions, we may exclude areas over 10,000 ft in altitude or having slopes exceeding 70 degrees as unlikely ever to be used for illicit crop culture. In

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addition, river and coastal areas exposed to siltation will be identified and included in the definition of 'affected regions'.

The temporal focus of this study includes the current situation as well as the previous five to ten years. The exact length of the retrospective analysis will be determined via the availability of imagery.

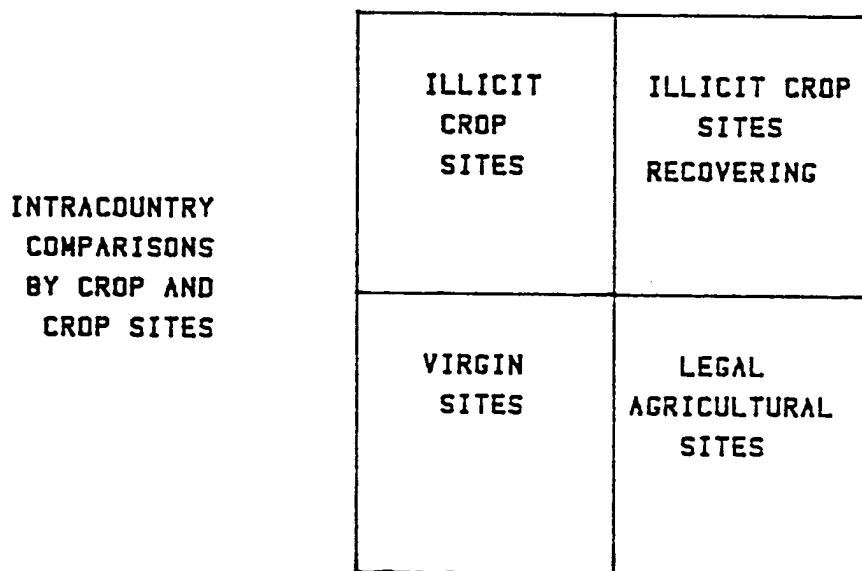
Some attention will need to be paid to effects across seasons. We will be carrying out this program during the dry season, and will not be able to directly view immediate effects during the rainy season. Therefore, we intend to discuss seasonal effects with in-country personnel so that we present a fair over-the-year picture.

The concept of an 'affected region' will be valuable in deriving environmental and socioeconomic implications of illicit narcotics crops cultivation. The 'affected region' definition will allow specification of the geographic scope of environmental, and socioeconomic damage. Knowing not only the extent of damage, but also the location within the country will facilitate deriving implications for the country as a whole.

Step B-3. Field Visit and Interviews. The field team will visit actual illicit and licit crop production sites in Jamaica, as well as conduct interviews with individuals identified during Task A, who are knowledgeable about tropical agriculture, forestry, and cultivation of marijuana. During the visits to altered sites, the field team will have two overall objectives. First, the altered sites, watersheds, and surrounding areas will be studied and also recorded with high quality still and video photography. Second, the field team will measure sites for resource levels and obtain corresponding spectral signatures with field spectral radiometers. Sites on which measurements are made must be reliably correlated to the hand-carried imagery and graphics by the field team.

It is anticipated that fly-over and on-ground visits can be made to unaltered (virgin) and legal agricultural sites in addition to illicit crop sites and sites recovering from illicit crop cultivation (Figure 3).

2



**FIGURE 3. ON-SITE VISITS SHOULD BE MADE TO VARIOUS
SITE TYPES TO ALLOW COMPARISONS OF EFFECTS**

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The field team will assess soil, biomass and timber, genetic, land and water resource levels both on undisturbed sites and on altered sites at different stages of recovery.

Step B-4. Apply Resource Loss Estimation Procedure to Entire Affected Regions. Each of the five resource loss estimation procedures will be applied to all affected sites identifiable in satellite imagery so as to estimate total resource losses for the 'affected regions'. Results will be expressed in physical units such as tons of soil, board feet of timber, etc. and will be entered into the GIS database.

In addition to current losses, the estimation procedure (where imagery exists) should be applied to the 'affected regions' for at least two previous time periods to derive retrospective estimates of losses.

Schedule

Steps B-1 and B-2 will be initiated during the meeting held during Step A-4, and should be completed by about the sixth week of the program. The date of the field visit is subject to change, but currently is scheduled for late in November. Step B-4 should begin upon the return of the field team from Jamaica.

Task C. Implications Analysis

In interpreting our findings, we expect to use a simple ranking system (high, medium, low) to better translate our knowledge into meaningful, lay-language findings. For example, we may be able to report a high extent and high magnitude consequence in certain regions, a low extent and low magnitude consequence in other regions. Out of these relative magnitude of loss estimates will flow levels of environmental concern and socioeconomic priorities. Given our findings at this stage, we will begin to draw formal conclusions relating to the environmental, and socioeconomic implications of growing the crops in the regions of interest. Meaningful implications will be described qualitatively and, where possible, quantitatively and monetarily.

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This Task closes with a detailed outline of our findings, implications, and reporting frameworks. At this point, we will schedule a meeting with the COTR so as to formally review progress and to finalize plans with respect to the content and nature of reporting.

Strategy

The output of the resource loss estimation procedure will be units of resources lost and gained, tracked by the area measurements of affected habitats. These data will be supplemented with estimates of normal background levels of resources and the normal resource cycling in undisturbed sites and watersheds. These data will be interpreted by the program team, and the implications for the 'affected regions' and the country as a whole will be expressed in environmental, and socioeconomic terms. In each case, future projections will be presented along with an analysis of the current and past situations. Brief perspectives on implications for the environmental, and socioeconomic categories follow:

- Environmental Implications -- Environmental implications for resource loss will be expressed fundamentally on a watershed basis. From these conclusions, the program team will derive environmental implications for the entire 'affected regions' in an extrapolative fashion. For example, habitat conversions, biomass changes, nutrient changes, species and genetic changes, and siltation of major rivers and coastal areas likely will be important environmental effects.
- Socioeconomic Implications -- Valuations will be placed on each of the environmental resources lost through illicit narcotics crops cultivation. Some valuations, such as those placed on timber or fuel are anticipated to be relatively straightforward. Others, such as those placed on genetic resources will involve making assumptions from field data and extrapolating over time.

*How does
relate to
defined region.*

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One aspect of the literature search will assess the merits of various resource valuation techniques. This literature along with along with techniques used by Battelle in other programs will be used to develop an integrated approach suitable for the Jamaican situation. Some examples of approaches for valuing natural and environmental resources include: 1) inferential, where the value of a nonmarket good such as genetic resources is inferred from the value of a market good; 2) contingent, where a hypothetical market is created; 3) restorative, where values are placed on the cost of replacing or restoring natural resources, and; 4) marginal, where the value of lost, but possible production is estimated (e.g., soil nutrient depletion resulting in lower biomass production).

Schedule

The full implications analyses must wait until after resource loss calculations have been made. However, we anticipate that implications analysis for certain aspects can start by about the end of the third month of the program.

Task D. Reporting

In reporting the results of this program, we propose providing two distinct deliverables: 1) a written report, and; 2) a graphics-oriented briefing package.

Written Report

A written report in two volumes will summarize the conclusions of the study. This report also will serve to record the methodologies used in the study, and to document the technical and scientific evidence for the conclusions. The first volume would be a concise "executive summary" consisting of five to ten pages which might be distributed to local leaders. We suggest that this first volume be written in lay language, be hard-hitting in a credible way, and contain color photographs and other presentation-quality

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graphics which support the key findings. The second volume (a set of appendices) will provide the technical discussion and documentation of our findings.

Briefing Package

The second reporting format will constitute a briefing package, usable by the client in face-to-face discussions with foreign leaders. The briefing package will allow the client to communicate the findings of this program graphically through slides and videotape, and not be dependent upon large amounts of written documentation to tell the story. The executive summary described above also could serve as a useful "brochure" accompanying the briefing package.

Specifically, the briefing package will consist of a set of slides, satellite images, and a 10- to 12-minute videotape. Narration-style captions (in English) will accompany the slides, and the videotape will be scripted.

It is important for the client to participate with the program team and Battelle's presentation specialists in editing the briefing package, selecting the slide captions, and assisting in videotape scripting.

Schedule

Preparation of the reporting materials can be completed after the analysis for Jamaica is completed. All materials will be turned over to the client between the fourth and fifth months of the program.

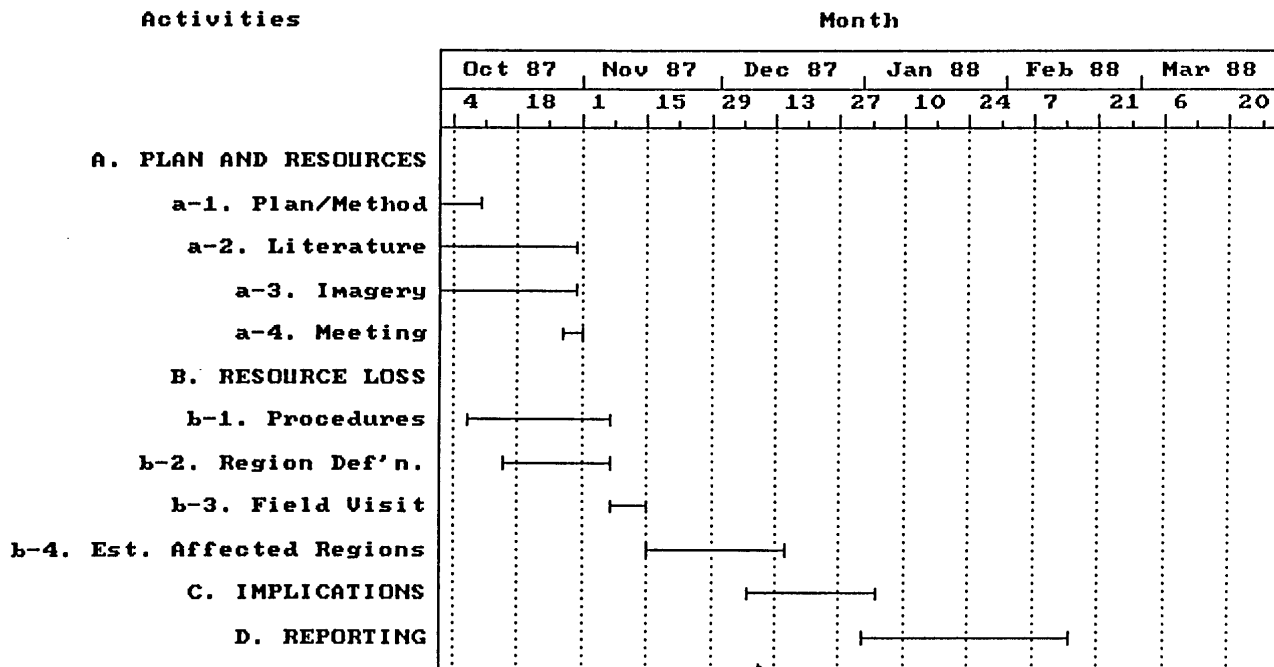
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PRELIMINARY SCHEDULE

Figure 4 illustrates a preliminary schedule for each of the Tasks discussed in the earlier section of this white paper. Contractually, we have assumed a six-month program beginning October 1, 1987. Given an October 1 start, our goal is to complete the Jamaican program by between February 1 and February 15. A later start will move completion back by a like amount.

Careful attention to planning and detail will enable this program to be completed on schedule. Of particular concern are possible slippages in being able to arrange the field visits and in obtaining unpublished documents, comparisons of satellite imagery, and photographs. The client liaison's assistance with necessary arrangements for the in-country visit is especially important.

Tentative Schedule Illicit Marijuana Production -- Jamaica



Assuming Oct. 1, 1987 Start

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CLIENT SUPPORT

We view this program as a cooperative effort between the client and Battelle. It is essential that a solid base of communication be maintained throughout the program. Battelle can provide appropriate assistance to the client in environmental, agricultural, socioeconomic, and remote sensing analyses relating to this area. It is important that the client's reservoir of staff expertise and physical assets be made available to this program.

In particular, we will need support from the client in the following areas:

- Provision of photos, satellite imagery, reports (from INM, DEA, and possibly other agencies), candidate in-country contacts, possibly certain INM staff expertise, and other resources relevant to this program.
- Assistance in interpreting and mensurating satellite imagery.
- Security clearances for some of the program team members, should clearances be required.
- Assistance in travel arrangements, and in assuring that appropriate area clearances, escorts, and other protective measures are taken for the safety of the program team.

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PROGRAM MANAGEMENT

This program will be managed by the Special Programs Office (SPO) under the direction of Mr. Tom Grimm, who reports directly to Dr. Frederick J. Milford, Vice President for Special Programs. The SPO will act as the Client's focal point for the program and will provide management review along with all report preparation such as monthly contract status reports, interim reports and the final contract report. Along with the Security Office, SPO acts to ensure that the spirit and letter of security regulations are followed. The SPO possesses all of the resources necessary for handling classified programs including appropriately cleared personnel, secure storage, Tempest approved computer, and a secure KY-71 telephone system.

Mr. D. Alan Scantland will be the Principal Investigator of the proposed research program. He has training in both the biological and socioeconomic sciences, has over 10 years experience in working with executive-level Clients on agriculturally oriented issues, and has strong skills in managing complex, multidisciplinary, and fast-moving programs. Mr. Scantland will be assigned to plan, direct, and schedule the research work on this program. We will be the primary contact with the Contracting Officers' technical representative on all matters related to scheduling, performance, and reporting of program research activities.

The proposed organization of the program includes participation of experienced staff from both Battelle-Columbus and Battelle-Northwest. Dr. Lou Martucci and Mr. George Wukelic will be the primary staff representing Battelle's Northwest Division (see Figure 5). Significant involvement of the Core Team members throughout the entire program is planned. Members of the Support Team will be available when needed to participate in certain highly focused aspects of the program.

Biographical sketches of personnel selected for the program are included in Appendix A.

Administrative / Field Work
disturbed / undisturbed baseline.
licit vs illicit

Soil: samples (cores structure vs nutrients)
tree diameters
radiometry
interviews w/ "experts"
slopes
species
tree heights
size (dimensions)
life cycles
genl site conditions

licit vs illicit
disturbed vs undisturbed
Spec. sites
undisturbed vs genl

Jim Whirlow
Young
Cornaby
Scantland

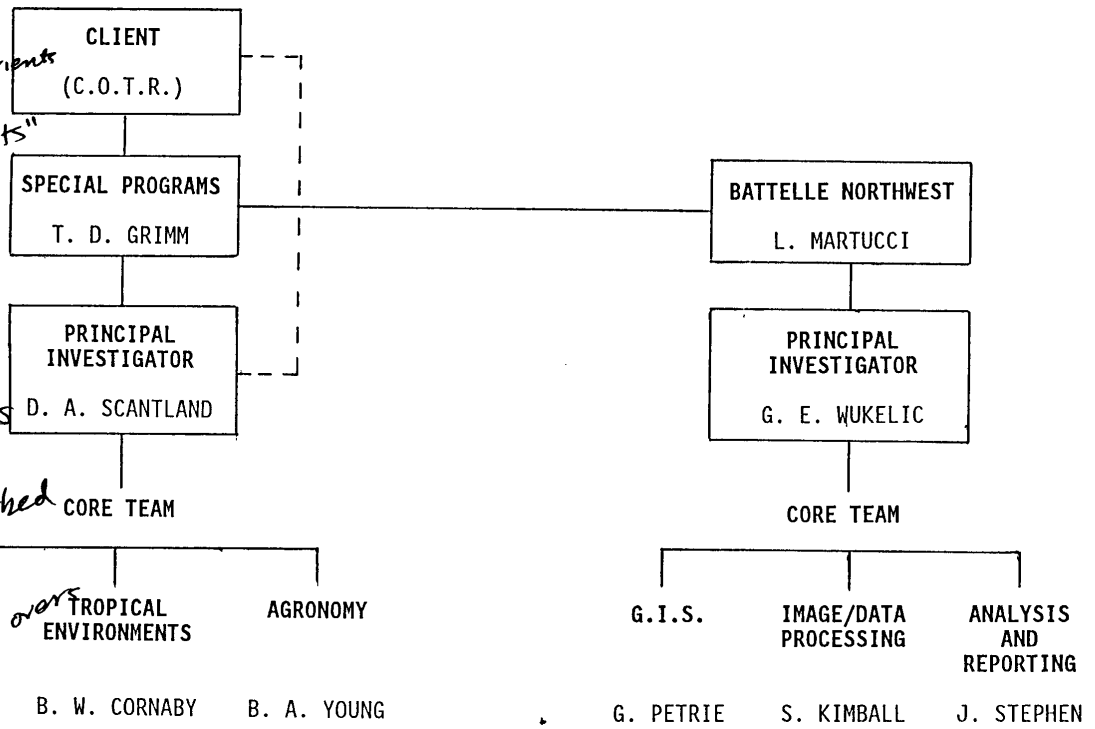


FIGURE 5. PROGRAM MANAGEMENT ORGANIZATION

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RELEVANT EXPERIENCE

The Program Team has the necessary skills and experiences to carry out this program effectively. Included within Appendix B are brief descriptions of a few programs we have conducted, and which illustrate the range of experiences which we can draw upon during this program. One or more members of the Program Team have worked on all of the Programs cited within Appendix B.

Staff Clearances

The current status (as of September 17) of security clearances by program team members is:

Battelle-Columbus:

Thomas D. Grimm -- Special Top Secret clearance granted
March 25, 1983
D. Alan Scantland -- Special Secret Pending September, 1987
Mickey R. Arthur -- Special Secret Pending September, 1987
Barney W. Cornaby -- Special Secret Pending September, 1987
Brian A. Young -- Special Secret Pending September, 1987
Thomas A. McClure -- Special Secret Pending September, 1987
John T. McGinnis -- Special Secret Pending September, 1987
Mason H. Soule -- Special Secret granted May 14, 1986
William J. Kelly -- Special Top Secret granted May 13, 1983

Battelle-Northwest:

Louis M. Martucci -- Special Top Secret granted February 10,
1983
George E. Wukelic -- Special Top Secret granted in 1978, updated
January 16, 1981
Greg M. Petrie -- DOE Q granted July 30, 1979, Special Secret to
be submitted
C. Scott Kimble -- DOE Q granted January 17, 1966, Special
Secret to be submitted
Joachim G. Stephan -- Special Secret granted July 27, 1965
Harlan P. Foote -- DOE Q granted January 17, 1966, Special
Secret to be submitted
Daniel Gibbons -- DOE Q
Leslie Guy McWethy -- DOE Q granted September 10, 1986

APPENDIX A

BIOGRAPHICAL SKETCHES

APPENDIX B

RELEVANT EXPERIENCE

APPENDIX C

CANDIDATE INTERVIEWEES

APPENDIX D

CAPABILITIES IN REMOTE SENSING/DIGITAL ANALYSIS

COST + FIXED

*Bryant
Analysis
Methodology
Rec*

ESTIMATED BATTELLE COSTS

<u>TASK</u>	<u>BATTELLE</u>	
	<u>ESTIMATED COSTS</u>	
	<u>\$000</u>	<u>Percent</u>
Task A. Planning and Resource Acquisition	\$ 58	21 %
Task B. Resource Loss Estimation	98	35
Task C. Implications	55	20
Task D. Reporting <i>video = 22,000</i>	66	24
<u>Totals</u>	<u>\$277</u>	<u>100 %</u>